JC17 Rec'd PCT/PTO 13 JUL 2001

FORM PTO-1390 REV. 2/01 U S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE **TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371**		ATTORNEY'S DOCKET NUMBER 08364.0024 U.S. APPLICATION NO. (If known, see 37 CFR 1.5) 09/889234
INTERNATIONAL APPLICATION NO. PCT/GB00/00089	INTERNATIONAL FILING DATE January 14, 2000	PRIORITY DATE CLAIMED January 15, 1999
TITLE OF INVENTION	LOAD SENSING SYSTEM	
APPLICANT(S) FOR DO/EO/US	Mark GLAZIER	

Applicant(s) herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☐ This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include items (5), (6), (9) and (21) indicated below.
4. ☒ The US has been elected by the expiration of 19 months from the priority date (Article 31).
5. ☒ A copy of the International Application as filed (35 U.S.C. 371 (c)(2)).
   - a. ☒ is attached hereto (required only if not communicated by the International Bureau).
   - b. ☒ has been communicated by the International Bureau.
   - c. ☐ is not required, as the application was filed with the United States Receiving Office (RO/US).
6. ☐ An English language translation of the International Application as filed (35 U.S.C. 371 (c)(2)).
   - a. ☐ is attached hereto.
   - b. ☐ has been previously submitted under 35 U.S.C. 154 (d)(4).
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371 (c)(3)).
   - a. ☐ are attached hereto (required only if not communicated by the International Bureau).
   - b. ☐ have been communicated by the International Bureau.
   - c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   - d. ☒ have not been made and will not be made.
8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371 (c)(3)).
9. ☐ An oath or declaration of the inventor(s) (35 U.S.C. 371 (c)(4)).
10. ☐ An English language translation of the annexes of the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371 (c)(5)).

Items 11 to 20 below concern document(s) or information included:

11. ☒ Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☒ A FIRST preliminary amendment.
14. ☐ A SECOND or SUBSEQUENT preliminary amendment.
15. ☐ A Substitute specification.
16. ☐ A change of power of attorney and/or address letter.
17. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821-1.825.
18. ☐ A second copy of the published international application under 35 U.S.C. 154 (d)(4).
19. ☐ A second copy of the English language translation of the international application 35 U.S.C. 154 (d)(4).
20. ☒ Other items or information:
   - a. ☒ Copy of cover page of International Publication No. WO00/41922.
   - b. ☐ Copy of Notification of Missing Requirements.
   - c. ☐

JC18 Rec'd PCT/PTO 13 JUL 2001

U.S. APPLICATION NO. (If known, see 37CFR 1.5) 09/889234	INTERNATIONAL APPLICATION NO. PCT/GB00/00089	ATTORNEY'S DOCKET NUMBER 08364.0024

21. ☒ The following fees are submitted:

	CALCULATIONS	PTO USE ONLY
BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)): Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO .... **$1000.00** International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO .... **$860.00** International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search fee (37 CFR 1.445(a)(2)) paid to USPTO .... **$710.00** International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4) .... **$690.00** International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33 (1)-(4) **$100.00**		
ENTER APPROPRIATE BASIC FEE AMOUNT =	$860.00	
Surcharge of **$130.00** for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (e)).	$	

CLAIMS	NUMBER FILED		NUMBER EXTRA	RATE		
Total Claims	56	- 20 =	36	x $18.00	$648	
Independent Claims	2	-3 =		x $80.00	$	
MULTIPLE DEPENDENT CLAIM(S) (if applicable)				+$270.00	$270.00	

TOTAL OF THE ABOVE CALCULATIONS =	$1778.00	
☐ Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by ½.	$889.00	
SUBTOTAL =	$889.00	
Processing fee of **$130.00** for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest priority date (37 CFR 1.492(f)).	$	
TOTAL NATIONAL FEE =	889.00	
Fee for recording the enclosed assignment (37 CFR 1.21 (h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). **$40.00** per property. +	$	
TOTAL FEES ENCLOSED =	$889.00	
	Amount to be refunded:	$
	charged:	$

a. ☒ A check in the amount of $ 889.00 to cover the above fees is enclosed.

b. ☐ Please charge my Deposit Account No. ________ in the amount of $ ________ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 06-0916. A duplicate copy of this sheet is enclosed.

d. ☐ Fees are to be charged to a credit card. **WARNING**: Information on this form may become public. **Credit card information should not be included on this form.** Provide credit card information and authorization on PTO-2038.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137 (a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

Finnegan, Henderson, Farabow, Garrett & Dunner, L.L.P
1300 I Street, N.W.
Washington, D.C. 20005-3315

SIGNATURE

Ernest F. Chapman, Reg. No. 25,961
NAME/REGISTRATION NO.

DATED: July 13, 2001

09/889234

13 JUL 2001

PATENT

Attorney Docket No.: 08364.0024

Customer Number: 22,852

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re U.S. national phase of PCT/GB00/00089

Mark GLAZIER

Serial No.: Not yet assigned | Group Art Unit:

Filed: July 13, 2001 | Examiner:

For: LOAD SENSING SYSTEM

PRELIMINARY AMENDMENT

BOX: PCT
Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

Prior to examination, please amend the above-identified application as follows:

IN THE CLAIMS:

Please cancel claims 1-31, without prejudice or disclaimer and add the following new claims 32-62.

32. (New) A vehicle having a body suspended on one or more axles by means of gas-filled suspension units, the vehicle being provided with means to vary the pressure within the suspension units to control the spacing between the body and the axle or axles and a braking system supplying a brake fluid to braking actuators operable to brake the vehicle's wheels, and further comprising a load sensing valve operable to apply a variable throttling effect to impede the flow of brake fluid to the braking actuators, characterised by further comprising means to vary the throttling effect of the load sensing valve in dependance on the pressure within the gas-filled suspension units.

LAW OFFICES
FINNEGAN, HENDERSON,
FARABOW, GARRETT,
& DUNNER, L.L.P.
1300 I STREET, N. W.
WASHINGTON, DC 20005
202-408-4000

33. (New) A vehicle according to claim 32, comprising a sensor for detecting the air pressure in the air suspension units, and control means responsive to the sensor output for varying the throttling effect of the load sensing valve.

34. (New) A vehicle according to claim 32 or 33, wherein the load sensing valve includes a movable throttling element having a first position wherein a maximum throttling effect is exerted, and a second position wherein a minimum throttling effect is exerted, and further comprises first actuating means to urge the throttling element toward its second position with a force dependant on the pressure in the gas-filled suspension units, and second actuating means to urge the throttling element toward its first position with a force dependant on the position of the throttling element and increasing as the throttling element approaches its second position.

35. (New) A vehicle according to claim 34, wherein the first actuating means is a fluid actuator to which the pressure of the gas-filled suspension units is communicated.

36. (New) A vehicle according to claim 35, wherein the first actuating means is an air bag.

37. (New) A vehicle according to claim 34, wherein the second actuating means is a fluid actuator supplied with a controlled pressure.

38. (New) A vehicle according to claim 37, wherein the second actuating means is an air bag.

39. (New) A vehicle according to claim 37, further comprising a pressure regulator means for supplying a reference fluid pressure to the second actuating means.

40. (New) A vehicle according to claim 39, wherein the pressure regulator means is capable of supplying a number of reference fluid pressures, the vehicle further

LAW OFFICES
FINNEGAN, HENDERSON,
FARABOW, GARRETT,
& DUNNER, L.L.P.
1300 I STREET, N. W.
WASHINGTON, DC 20005
202-408-4000

comprising pressure sensing means operable to sense the pressure in the suspension units and control means operable to select one of said reference fluid pressures on the basis of the sensed pressure and to supply said selected reference fluid pressure to the second actuating means.

41. (New) A vehicle according to claim 40, wherein the pressure regulator means is capable of supplying first and second reference pressures, and the pressure sensing means provides a first output when the sensed pressure is below a predetermined threshold and a second output when the sensed pressure is above the predetermined threshold, and the control means is operable to provide the first reference pressure to the second actuating means when the pressure sensing means provides the first output, and to provide and second reference pressure to the second actuating means when the pressure sensing means provides the second output.

42. (New) A vehicle according to claim 34, wherein the second actuator is a resilient element.

43. (New) A vehicle according to claim 42, wherein the resilient element is a spring.

44. (New) A vehicle according to claim 32 or 33, wherein the load sensing valve includes a movable throttling element having a first position wherein a maximum throttling effect is exerted, and a second position wherein a minimum throttling effect is exerted, and further comprises a positioning actuator operable to position the throttling element at a point between its first and second positions.

LAW OFFICES
FINNEGAN, HENDERSON,
FARABOW, GARRETT,
& DUNNER, L.L.P.
1300 I STREET, N. W.
WASHINGTON, DC 20005
202-408-4000

45. (New) A vehicle according to claim 44, further comprising means for sensing the pressure within the gas-filled suspension units, and control means responsive to the sensed pressure to control the positioning actuator.

46. (New) A vehicle according to claim 45, further including sensing means to detect the spacing between the body and the axle, wherein the control means controls the positioning actuator in dependence on detected spacing and on the pressure within the suspension units.

47. A vehicle according to claim 45, wherein the control means comprises means to determine a desired position for the throttling means on the basis of the sensed pressure, and means to operate the positioning actuator to bring the throttling means to the desired position.

48. (New) A vehicle according to claim 45, wherein the output of the pressure sensing means is an electrical signal.

49. (New) A load sensing system for a braking system of a vehicle having a vehicle body supported on an axle by a pressurised air suspension unit whose pressure is varied as the vehicle load varies, the load sensing system comprising a variable throttling valve operable to control the flow of brake fluid to a brake actuator, and control means to vary the throttling effect of the throttling valve in dependence on the pressure in the air suspension unit.

50. (New) A load sensing system according to claim 49, comprising a sensor for detecting the air pressure in the air suspension units, and control means responsive to the sensor output for varying the throttling effect of the load sensing valve.

LAW OFFICES
FINNEGAN, HENDERSON, FARABOW, GARRETT, & DUNNER, L.L.P.
1300 I STREET, N. W.
WASHINGTON, DC 20005
202-408-4000

51. (New) A load sensing system according to claim 49 or 50, wherein the variable throttling valve comprises a valve element movable between closed and open positions to vary the throttling effect, and a fluid pressure actuator responsive to the pressure in the suspension unit and operable to urge the valve element toward its open position against a restoring force.

52. (New) A load sensing system according to claim 51, wherein the restoring force is provided by a second fluid pressure actuator.

53. (New) A load sensing system according to claim 52, wherein the second fluid pressure actuator is supplied with fluid at a regulated pressure.

54. (New) A load sensing system according to claim 52, wherein the second fluid pressure actuator is an air bag.

55. (New) A load sensing system according to claim 53, further comprising a pressure regulator means for supplying a reference fluid pressure to the second actuating means.

56. (New) A load sensing system according to claim 55, wherein the pressure regulator means is capable of supplying a number of reference fluid pressures, the vehicle further comprising a pressure sensing means operable to detect the pressure in the suspension units and control means operable to select one of said reference fluid pressure on the basis of the sensed pressure and to supply said selected reference fluid pressure to the second actuating means.

57. (New) A load sensing system according to claim 56, wherein the pressure regulator means is capable of supplying first and second reference pressures, and the pressure sensing means provides a first output when the sensed pressure is below a

LAW OFFICES
FINNEGAN, HENDERSON,
FARABOW, GARRETT,
& DUNNER, L.L.P.
1300 I STREET, N. W.
WASHINGTON, DC 20005
202-408-4000

predetermined threshold and a second output when the sensed pressure is above the predetermined threshold, and the control means is operable to provide the first reference pressure to the second actuating means when the pressure sensing means provides the first output, and to provide the second reference pressure to the second actuating means when the pressure sensing means provides the second output.

58. (New) A load sensing system according to claim 51, wherein the restoring force is provided by a resilient element.

59. (New) A load sensing system according to claim 58, wherein the restoring force is provided by a spring.

60. (New) A load sensing system according to claim 51, wherein the restoring force increases as the valve element approaches its open position.

61. (New) A load sensing system according to claim 50, wherein the pressure in the air suspension unit is sensed by an electrical or electromechanical sensor to provide an electrical output signal corresponding to the suspension unit pressure, and the variable throttling valve is electrically controllable to vary the flow of brake fluid to a brake actuator, and the control means comprises a control circuit varies the throttling effect of the throttling valve in dependence on the output signal from the pressure sensor.

62. (New) A load sensing system according to claim 50, comprising a detector responsive to a spacing between the vehicle body and the axle, a sensor to give an electrical output corresponding to suspension unit pressure, and an electrically controllable throttling valve to vary the flow of brake fluid to a brake actuator, the control means providing control signals to the throttling valve in dependence on the sensed suspension unit pressure and the spacing between the vehicle body and axle.

LAW OFFICES
FINNEGAN, HENDERSON,
FARABOW, GARRETT,
& DUNNER, L.L.P.
1300 I STREET, N. W.
WASHINGTON, DC 20005
202-408-4000

REMARKS

The claims have been amended to conform them to U.S. practice. The amendment is fully supported by the specification, original claims, and drawings, will not require an additional search, and does not raise new issues. Therefore, applicant respectfully requests that this Preliminary Amendment be entered and the requested changes made.

The examiner is respectfully requested to consider the above preliminary amendment prior to examination of the application.

If there are any fees due in connection with the filing of this amendment, please charge the fees to Deposit Account No. 06-0916. If a fee is required for an extension of time under 37 C.F.R. § 1.136 not accounted for above, such an extension is requested and the fee should also be charged to our deposit account.

Respectfully submitted,
FINNEGAN, HENDERSON, FARABOW,
GARRETT & DUNNER, L.L.P.

By: ______________________
Ernest F. Chapman
Reg. No. 25,961

Date: July 13, 2001
EFC/FPD/peg

LAW OFFICES
NNEGAN, HENDERSON,
FARABOW, GARRETT,
& DUNNER, L.L.P.
1300 I STREET, N. W.
VASHINGTON, DC 20005
202-408-4000

09/889234
JC18 Rec'd PCT/PTO 13 JUL 2001

Load Sensing System

The present invention relates to braking systems for vehicles, and is particularly concerned with braking systems for passenger or load-carrying vehicles, most particularly light commercial vehicles.

Commercial vehicles have for many years been fitted with servo braking systems which apply brake fluid, which may be a hydraulic fluid or air, to brake actuator cylinders in response to control inputs from the vehicle driver. Pressure of the driver's foot on a brake pedal controls the flow of brake fluid to operate the brake actuator cylinders and apply brake shoes or pads to the vehicle wheel hubs or brake discs, respectively. The fluid is provided to the actuator cylinder from a high-pressure source via a servo device. By this means, the force applied by the driver to the pedal is amplified to the levels necessary to arrest the movement of a heavy vehicle.

In commercial vehicles, it is desirable for the vehicle to be able to carry a large payload in proportion to the unladen weight of the vehicle, and thus there is great variation between the unladen and fully laden weights of such vehicles. When the vehicle is unladen, deceleration can be achieved satisfactorily with

relatively low fluid pressures in the brake actuator cylinders. As the total weight of the vehicle increases, braking requires higher fluid pressures in the brake actuator cylinders in order to produce the same deceleration rate. It is also necessary to provide a braking system which provides predictability to the driver, by giving the same or similar deceleration rates for similar pedal pressures at any loading state of the vehicle. This is achieved by providing a braking system which, for the same pedal pressure applied by the driver, applies less fluid pressure to the brake actuator cylinders when the vehicle is unladen than when it is heavily loaded.

To effect such a control of the vehicle braking system, it is conventional to provide a throttling valve, known as the "load sensing valve" in the fluid circuit supplying the brake actuator cylinders. The load sensing valve comprises a valve body and an operating arm, the valve body having a passage provided with a variable throttling element whose throttling effect is varied by moving the operating arm. The valve body is conventionally fixed relative to the vehicle body and the operating arm is attached to an axle of the vehicle on spring-suspended vehicles. This arrangement may however be reversed. As more load is placed on the vehicle, the

suspension springs are compressed, and the distance between the points to which the load sensing valve is attached varies as the axle moves nearer to the vehicle body. The compression of the suspension springs progressively reduces the "ride height" of the vehicle as it is more heavily loaded, and acts as an indicator of the weight of the vehicle. An individual correlation will therefore exist between the loading state and the ride height of the vehicle, depending on the characteristics of the suspension springs. The driver of the vehicle will become accustomed to the braking performance of the vehicle at various loading states.

The operation of the load sensing valve is to provide a strong throttling action to reduce the flow of brake fluid to the brake actuator cylinders when the vehicle is lightly loaded, and when the vehicle is heavily loaded to provide little or no throttling action and allow brake fluid to flow unimpeded to the brake actuator cylinders when the driver applies pedal pressure. The actual braking effect generated by the brake actuator cylinders thus increases as the vehicle is more heavily loaded. Each vehicle has a design relationship between the gross weight and the braking amplification factor, calling for a predetermined variation of the degree of throttling provided by the

load sensing valve over the range of vehicle weight from unladen to maximum gross weight. Typically, the load sensing valve will reduce the brake fluid pressure by some 1500psi when the vehicle is unladen, and will allow free flow when the vehicle is at its maximum gross weight.

In recent years the use of "air suspension" has become widespread in heavy goods vehicles. However, in applying this technology to light goods and passenger vehicles, vans or the like a significant difficulty has emerged as regards the variation of braking performance with vehicle weight.

In vehicles using air suspension, the vehicle is supported on its axles not by springs but by suspension units or "bags" filled with air under pressure. The "bags" may be flexible structures of toroidal or other form, or may be telescoping structures having sliding or rolling diaphragm seals. The "ride height" of the vehicle is controlled by varying the pressure within the bags, and thus is no longer dictated by the gross vehicle weight. The bags may also be inflated or deflated to raise or lower the vehicle body in relation to the ground, this feature being of great assistance in loading the vehicle, since by lowering the vehicle body the height to which cargo need be lifted to enter the

vehicle's loadspace is reduced.

It has been found that the handling and "driveability" of the vehicle is improved by adopting a control system for the bag pressure which adjusts the ride height to a maintain it at a constant level slightly below the unladen position. Such a control provides for a predetermined amount of suspension travel at all loading states, to maintain the ground clearance of the vehicle at a required distance. Ride height control may be achieved by admitting air into or venting air from the bags in response to a measurement of ride height. Maintaining a constant ride height however means that the ride height cannot be used as an indicator of the vehicle's gross weight in a control arrangement for the braking system.

An objective of the present invention is to provide a braking system for a vehicle with air suspension, wherein the brake servo amplification factor increases in proportion to an increase of the gross vehicle weight.

Another objective of the invention is to provide a braking system for a vehicle with air suspension, wherein the braking performance varies as a function of the gross vehicle weight throughout a predetermined weight range.

A further objective is to provide a load sensing arrangement for a vehicle with air suspension, operable

to control the braking system of the vehicle in accordance with the gross vehicle weight.

A yet further objective of the invention is to provide a combined air suspension and braking system for a vehicle, whereby a substantially constant ride height may be maintained and the braking effect varied in accordance with the gross vehicle weight.

In accordance with a first aspect of the invention, there is provided a vehicle having a body suspended on one or more axles by means of gas-filled bags, the vehicle being provided with means to vary the pressure within the bags to control the spacing between the body and the axle or axles and a braking system supplying a brake fluid to braking actuators operable to brake the vehicle's wheels, and further comprising a load sensing valve operable to apply a variable throttling effect to impede the flow of brake fluid to the braking actuators, characterised in that the throttling effect of the load sensing valve is varied by a control means responsive to the pressure within the gas-filled bags.

A second aspect of the present invention provides a load sensing arrangement for a braking system of a vehicle with air suspension, the load sensing arrangement comprising a sensor for detecting the air pressure in the air suspension, a variable throttling valve operable to

control the flow of brake fluid to a brake actuator, and control means to vary the throttling effect of the throttling valve in dependence on the output of the pressure sensor.

In an advantageous embodiment of the load sensing arrangement, the variable throttling valve comprises a valve element movable between closed and open positions to vary the throttling effect, and a fluid pressure actuator responsive to the pressure in the air suspension and operable to urge the valve element toward its open position against a restoring force. The restoring force may be provided by a second fluid pressure actuator, or by a resilient element such as a spring. The second fluid pressure actuator may be supplied with fluid at a reference pressure. Alternatively, the second fluid pressure actuator may be supplied with fluid at one of a number of pressures selected on the basis of the vehicle load.

In an alternative embodiment of the load sensing arrangement, the pressure in the air suspension is sensed by an electrical or electromechanical sensor to provide an electrical output signal corresponding to the suspension pressure, and the variable throttling valve is electrically controllable to vary the flow of brake fluid to a brake actuator, and a control circuit varies the

throttling effect of the throttling valve in dependence on the output signal from the pressure sensor. It is further foreseen that the suspension and braking systems may be interlinked by an electrical or electronic control means, by providing sensors giving electrical output signals relating to ride height to control the supply of air to the suspension units, a detector to give an electrical output corresponding to suspension unit pressure, and an electrically controllable throttling valve to vary the flow of brake fluid to a brake actuator, the control means providing control signals to the throttling valve in dependence on the sensed suspension unit pressure.

Embodiments of the invention will now be described in detail with reference to the accompanying drawings, in which:

Figure 1 shows a schematic view of an air suspension system and associated braking system according to a first embodiment;

Figures 2A and 2B are a schematic views of the load sensing valve of the suspension and braking system of Figure 1 when the vehicle is lightly loaded and heavily loaded, respectively;

Figure 3 is a schematic diagram showing an alternative load sensing arrangement using electrical

sensors;

Figure 4 is a schematic diagram of the control system of the embodiment shown in Figure 3; and

Figure 5 is a schematic diagram similar to Figure 1 illustrating a further alternative embodiment of the braking control system.

Referring to Figure 1, there is shown an air suspension system for a vehicle comprising an air compressor 1, an air reservoir 2, a ride height sensor 3 and a pair of air bags 4. The air bags 4 are positioned between the vehicle body (not shown) and the vehicle axle, to support the body.

The ride height sensor 3 is a valve which in one control position can admit air from the reservoir 2 to the air bags 4, and in a second control position seals the air bags from the reservoir, and in a third control position can allow air to escape from the air bags 4 to atmosphere. The ride height sensor 3 is conventionally mounted to the vehicle body, and has a control element linked to an axle. As the axle is moved relative to the vehicle body, the control element of the ride height sensor moves to place the ride height valve in one of the three control positions. The arrangement is such that when the vehicle body is in the datum position relative to the axle, the ride height sensor is in its second

position and air is neither admitted to nor vented from the air bags 4. The datum position of the body is set to be slightly below the body height at maximum suspension extension, to provide for the maximum usable suspension travel during operation of the vehicle while enabling the suspension to lift the vehicle body slightly above datum height during a transition from a loaded to an unloaded state.

When an increase in load compresses the air bags 4, and lowers the vehicle body from its datum position, the ride height sensor is moved to its first control position and air is admitted to the air bags to reinflate them until the datum height is regained.

With a decrease in load, the air bags 4 expand and lift the vehicle body slightly above its datum position. The ride height sensor is then moved to its third control position and air is vented from the air bags to deflate them until the vehicle body returns to datum height.

The vehicle braking system comprises a brake pedal 10, linked to a master cylinder 11 to provide a brake pressure input to a servo 12. Servo 12 increases the brake pressure and supplies the increased pressure to load sensing valve 13. Valve 13 throttles the brake fluid, and controls its passage to brake actuator cylinder 14. When fluid is supplied to the actuator

cylinder 14, brake shoes 15 expand to contact brake drum 16 and slow the vehicle. While an expanding shoe drum brake has been shown schematically in the Figure, it will be understood that any brake mechanism operated by fluid pressure may be used. Likewise it is to be understood that the fluid pressure may be transmitted by hydraulic fluid or other liquid, or by a compressed gas such as air.

The load sensing valve is shown schematically in Figures 2A and 2B, and comprises a valve body 20 having an inlet 21 and an outlet 22 for brake fluid. An internal passage 23 in the body 20 connects the inlet 21 to the outlet 22, and includes a throttling element 24 controlled by a swinging arm 25. The position of the swinging arm 25 determines the amount of throttling or flow restriction in the passage 23 by advancing or retracting throttling element 24 into or from the passage 23.

Two actuators 26 and 27 exert forces on the swinging arm 25. Actuator 26 is a fluid actuator, in this case an air bag similar to the air bags 4 but on a reduced scale, and is in fluid communication via a duct 28 with the air bags 4 of the suspension system. Fluid pressure within the actuator 26 is the same as the fluid pressure in the air bags 4, and is thus dependent on the gross vehicle

weight. The force exerted by the actuator 26 on the swinging arm 25 is in the sense of retracting the throttling element 24 from the passage 23, i.e. decreasing the throttling effect of throttling element 24.

A second actuator 27 acts on the swinging arm 25, in the opposite sense to the actuator 26. Fluid pressure is supplied to the second actuator 27 from the reservoir 2, via a pressure regulator 29 (seen in Figure 1). The pressure within the actuator remains constant, but it is a feature of the air bag type of actuator that its "spring rate" increases as its volume decreases.

In operation, the load sensing valve is in the position shown in Figure 2A when the vehicle is lightly loaded. An increase in vehicle weight causes the vehicle body to drop, and the ride height sensor 3 operates to provide compressed air to the air bags 4 to lift the body back to its datum position. The pressure within the air bags 4 is thus increased, and this increased pressure is transmitted via duct 28 to the actuator 26, increasing its force. The increased force of actuator 26 overcomes the resistance of actuator 27, and swinging arm 25 moves to a new position (Figure 2B) in which the throttling element 24 is retracted from the passage 23 to reduce the throttling effect of the load sensing valve. The

actuator 27, although supplied with fluid at a constant reference pressure, provides a progressively increasing resistance force as the actuator 27 is compressed.

Similarly, as the vehicle weight is reduced, the ride height sensor 3 causes a pressure drop in the suspension air bags 4, and thus also in actuator 26, allowing actuator 27 to move the swinging arm 25 clockwise as seen in Figures 2A and 2B to increase the throttling effect of the load sensing valve.

The second actuator is a fluid actuator in the embodiment shown, but in alternative embodiments may be a resilient element such as a tension or compression spring, or a torsion spring operating on the swinging arm pivot. The spring may have a constant or a variable rate, i.e. the spring force may vary linearly or non-linearly as the position of the swinging arm changes.

In the embodiment shown in Figure 3, the fluid communication via duct 28 between the braking and suspension systems is replaced by an electronic control system. In Figure 3, the suspension system again comprises a compressor 1, a reservoir 2 and air bags 4. A ride height sensor 30, which may be a variable resistor or capacitance or a position sensor cooperating with the suspension members, is arranged to produce an electrical output signal corresponding to the ride height.

An electromechanical valve 35 serves as the "load sensing valve", and is controllable by the control circuit 31 to exert a variable throttling effect on brake fluid passing from servo 36 to brake assembly 37.

The control circuit 31 is seen in detail in figure 4, and comprises a memory 40 for storing data, a processor 41, ROM memory 42 for storing operation programs, and RAM 43 providing working memory for the processor 41.

Sensor inputs from the ride height sensor 30 and the pressure transducer 34 are provided to control circuit 31, as are inputs from the input device 32. A display 43 may be provided to display parameters such as desired ride height. The control circuit provides control signals to a ride height valve 33, and to an electromechanical valve 35.

The output signal from ride height sensor 30 is fed to the control circuit 31, which compares the sensed ride height value with a desired ride height value stored in memory 40. The desired ride height value may be selected by the driver using an input device such as a keyboard 32. On the basis of the comparison, control circuit 31 provides a control signal to the ride height valve 33 either to admit air to the air bags 4, or vent air therefrom, to bring the sensed ride height to the desired

ride height.

A pressure transducer 34 then senses the pressure in the air bags 4, and provides an output signal to the control circuit 31 corresponding to the sensed pressure. This output is also indicative of the vehicle weight when the vehicle is at the desired ride height, since the ride height adjustment raises or lowers the pressure in accordance with the vehicle weight.

On the basis of the sensed pressure, control circuit 31 provides control signals to an electromechanical valve 35 in the braking circuit to vary its throttling effect. The valve 35 acts in the same way as the load sensing valve 13 of the embodiment shown in Figure 1. The control circuit may include a look-up table 40a in memory 40 correlating values of sensed air bag pressure at the desired ride height with required positions for the throttle valve.

In an alternative embodiment, a conventional load sensing valve may be used, with an electromechanical actuator, such as a linear motor or a stepper motor and gearing, controlled by the control circuit 31 to position the swinging arm of the load sensing valve at the appropriate position for the sensed vehicle weight. Such an arrangement is contemplated for retro-fitting air suspension to light commercial vehicles originally

equipped with spring suspension.

The memory 40 of control circuit 31 may be provided with a look-up table 40a correlating a range of values of ride height and suspension air bag pressure with gross vehicle weight, so that for any combination of sensed values of pressure and ride height, the gross vehicle weight can be immediately read out from the table. Valve 35 can then be controlled on the basis of this gross weight value, without having to wait for the ride height control to inflate or deflate the air suspension to reach the desired ride height value for sensing the air bag pressure and thereby obtaining the gross weight. The look-up table 40a may be generated in a calibration process wherein the ride height is varied at different gross weights, and correlating pairs of sensor outputs from the ride height and air pressure sensors are noted for each loading state.

The display 43 may be provided with data to display the instantaneous vehicle weight and actual ride height, and input device 32 may be used by the driver to raise or lower the ride height for loading and unloading, for example to match the vehicle height to a loading dock or kerb. For example, the control circuit 31 may include circuitry enabling the driver to increase or decrease the ride height incrementally, for example in 10mm steps, to

match a loading dock height and the vehicle load bed height.

Figure 5 shows an alternative embodiment of the suspension and braking control system. In this Figure components corresponding to components in Figure 1 have been assigned the same reference numerals. In Figure 5, the compressor 1 supplies air to the air reservoir 2, which supplies air via a water separator 52 and a non-return valve 53 to the ride height sensor 3. Air is supplied to the suspension air suspension airbags 4 via a line 54, in which a pressure switch 55 is installed to sense the air suspension pressure.

The pressure switch 55 is operatively connected to pressure regulator 29, which controls the air pressure in the second actuator 27. Pressure regulator 29 is capable of supplying air to the second actuator 27 at at least two controlled pressures, the reference pressure output by regulator 29 being selected in accordance with the air pressure sensed by the pressure switch 55.

In a first control arrangement, the pressure switch 55 is configured as a threshold detector, and gives a first output when the sensed pressure is below a predetermined threshold, and a second output when the sensed pressure is above that threshold. The pressure regulator 29 is arranged to provide first and second

reference pressures, and is operatively connected to the threshold detector 55 so that when the sensed pressure in the air suspension is below the threshold, the pressure regulator 29 provides a lower reference pressure to the second actuator 27. When the sensed pressure in the suspension is above the threshold, the pressure regulator 29 provides a higher reference pressure to the second actuator 27. In a typical arrangement in which the axle load of the vehicle varies from 700kg to 3200kg, the pressure in the suspension airbags may vary from 3.4 to 7.5 bar (50 to 110 psi) and the pressure supplied to the second actuator 27 may be 1.5 bar (22 psi) when the air suspension pressure is at or below 5.8 bar (85 psi), and 1.9 bar (28 psi) when the air suspension pressure is above 5.8 bar.

In a second, alternative control arrangement the pressure switch 55 may be configured with a number of thresholds, dividing the range of pressure variation in the suspension airbags into a plurality of sub-ranges. The pressure regulator 29 may then be configured to provide a plurality of different reference pressures, each corresponding to one of the sub-ranges. In the typical example referred to above, the pressure switch 55 and pressure regulator 29 may be configured to deliver a

first reference pressure of 1.5 bar (22 psi) when the suspension pressure is from 3.4 to 3.8 bar (50 to 55 psi), a second reference pressure of about 1.58 bar (23 psi) when the suspension pressure is from 3.8 to 4.1 bar (55 to 60 psi), a third reference pressure of about 1.65 bar (24 psi) when the suspension pressure is from 4.1 to 4.47 bar (60 to 65 psi), a fourth reference pressure of about 1.72 bar (25 psi) when the suspension pressure is from 4.47 to 4.8 bar (65 to 70 psi), a fifth reference pressure of about 1.79 bar (26 psi) when the suspension pressure if from 4.8 to 5.1 bar (70 to 75 psi), a sixth reference pressure of about 1.86 bar (27 psi) when the suspension pressure is from 5.1 to 5.5 bar (75 to 80 psi), and a seventh reference pressure of about 1.9 bar (28 psi) when the suspension pressure is above 5.5 bar (80 psi).

As an alternative to a single pressure regulator 29 which can supply a plurality of different reference pressures, each of the reference pressures may be provided by a separate pressure regulator 29, with the pressure sensor 55 controlling a selector valve arrangement to connect the appropriate pressure regulator 29 to the second actuator 27.

In a third alternative control arrangement, the pressure

regulator 29 may be adapted to provide a continuously variable reference pressure to the second actuator 27, and may be controlled by the pressure sensor 55 to increase the reference pressure in the second actuator from about 1.5 bar (22 psi) to about 1.9 bar (28 psi) as the sensed pressure in the suspension airbags increases of from about 3.4 top about 5.5 bar (50 to 80 psi).

CLAIMS

1. A vehicle having a body suspended on one or more axles by means of gas-filled suspension units, the vehicle being provided with means to vary the pressure within the suspension units to control the spacing between the body and the axle or axles and a braking system supplying a brake fluid to braking actuators operable to brake the vehicle's wheels, and further comprising a load sensing valve operable to apply a variable throttling effect to impede the flow of brake fluid to the braking actuators, characterised by further comprising means to vary the throttling effect of the load sensing valve in dependance on the pressure within the gas-filled suspension units.

2. A vehicle according to claim 1, comprising a sensor for detecting the air pressure in the air suspension units, and control means responsive to the sensor output for varying the throttling effect of the load sensing valve.

3. A vehicle according to claim 1 or claim 2, wherein the load sensing valve includes a movable throttling element having a first position wherein a maximum

throttling effect is exerted, and a second position wherein a minimum throttling effect is exerted, and further comprises first actuating means to urge the throttling element toward its second position with a force dependant on the pressure in the gas-filled suspension units, and second actuating means to urge the throttling element toward its first position with a force dependant on the position of the throttling element and increasing as the throttling element approaches its second position.

4. A vehicle according to claim 3, wherein the first actuating means is a fluid actuator to which the pressure of the gas-filled suspension units is communicated.

5. A vehicle according to claim 3 or claim 4, wherein the first actuating means is an air bag.

6. A vehicle according to any of claims 3 to 5, wherein the second actuating means is a fluid actuator supplied with a controlled pressure.

7. A vehicle according to claim 6, wherein the second actuating means is an air bag.

8. A vehicle according to claim 6 or claim 7, further comprising a pressure regulator means for supplying a reference fluid pressure to the second actuating means.

9. A vehicle according to claim 8, wherein the pressure regulator means is capable of supplying a number of reference fluid pressures, the vehicle further comprising pressure sensing means operable to sense the pressure in the suspension units and control means operable to select one of said reference fluid pressures on the basis of the sensed pressure and to supply said selected reference fluid pressure to the second actuating means.

10. A vehicle according to claim 9, wherein the pressure regulator means is capable of supplying first and second reference pressures, and the pressure sensing means provides a first output when the sensed pressure is below a predetermined threshold and a second output when the sensed pressure is above the predetermined threshold, and the control means is operable to provide the first reference pressure to the second actuating means when the pressure sensing means provides the first output, and to provide the second reference pressure to the second actuating means when the pressure sensing means provides the second output.

11. A vehicle according to any of claims 3 to 5, wherein the second actuator is a resilient element.

12. A vehicle according to claim 11 wherein the resilient element is a spring.

13. A vehicle according to claim 1 or claim 2, wherein the load sensing valve includes a movable throttling element having a first position wherein a maximum throttling effect is exerted, and a second position wherein a minimum throttling effect is exerted, and further comprises a positioning actuator operable to position the throttling element at a point between its first and second positions.

14. A vehicle according to claim 13, further comprising means for sensing the pressure within the gas-filled suspension units, and control means responsive to the sensed pressure to control the positioning actuator.

15. A vehicle according to claim 14, further including sensing means to detect the spacing between the body and the axle, wherein the control means controls the positioning actuator in dependence on detected spacing and on the pressure within the suspension units.

16. A vehicle according to claim 14 or claim 15, wherein the control means comprises means to determine a desired position for the throttling means on the basis of the sensed pressure, and means to operate the positioning actuator to bring the throttling means to the desired position.

17. A vehicle according to any of claims 14 to 16, wherein the output of the pressure sensing means is an electrical signal.

18. A load sensing system for a braking system of a vehicle having a vehicle body supported on an axle by a pressurised air suspension unit whose pressure is varied as the vehicle load varies, the load sensing system comprising a variable throttling valve operable to control the flow of brake fluid to a brake actuator, and control means to vary the throttling effect of the throttling valve in dependence on the pressure in the air suspension unit.

19. A load sensing system according to claim 18 comprising a sensor for detecting the air pressure in the air suspension units, and control means responsive to the sensor output for varying the throttling effect of the

load sensing valve.

20. A load sensing system according to claim 18 or claim 19, wherein the variable throttling valve comprises a valve element movable between closed and open positions to vary the throttling effect, and a fluid pressure actuator responsive to the pressure in the suspension unit and operable to urge the valve element toward its open position against a restoring force.

21. A load sensing system according to claim 20, wherein the restoring force is provided by a second fluid pressure actuator.

22. A load sensing system according to claim 21, wherein the second fluid pressure actuator is supplied with fluid at a regulated pressure.

23. A load sensing system according to claim 21, wherein the second fluid pressure actuator is an air bag.

24. A load sensing system according to claim 22 or claim 23, further comprising a pressure regulator means for supplying a reference fluid pressure to the second actuating means.

25. A load sensing system according to claim 24, wherein the pressure regulator means is capable of supplying a number of reference fluid pressures, the vehicle further comprising a pressure sensing means operable to detect the pressure in the suspension units and control means operable to select one of said reference fluid pressure on the basis of the sensed pressure and to supply said selected reference fluid pressure to the second actuating means.

26. A load sensing system according to claim 25, wherein the pressure regulator means is capable of supplying first and second reference pressures, and the pressure sensing means provides a first output when the sensed pressure is below a predetermined threshold and a second output when the sensed pressure is above the predetermined threshold, and the control means is operable to provide the first reference pressure to the second actuating means when the pressure sensing means provides the first output, and to provide the second reference pressure to the second actuating means when the pressure sensing means provides the second output.

27. A load sensing system according to claim 20, wherein the restoring force is provided by a resilient element.

28. A load sensing system according to claim 27, wherein the restoring force is provided by a spring.

29. A load sensing system according to any of claims 20 to 28, wherein the restoring force increases as the valve element approaches its open position.

30. A load sensing system according to claim 19, wherein the pressure in the air suspension unit is sensed by an electrical or electromechanical sensor to provide an electrical output signal corresponding to the suspension unit pressure, and the variable throttling valve is electrically controllable to vary the flow of brake fluid to a brake actuator, and the control means comprises a control circuit varies the throttling effect of the throttling valve in dependence on the output signal from the pressure sensor.

31. A load sensing system according to claim 19, comprising a detector responsive to a spacing between the vehicle body and the axle, a sensor to give an electrical output corresponding to suspension unit pressure, and an electrically controllable throttling valve to vary the flow of brake fluid to a brake actuator, the control means providing control signals to the throttling valve

in dependence on the sensed suspension unit pressure and the spacing between the vehicle body and axle.

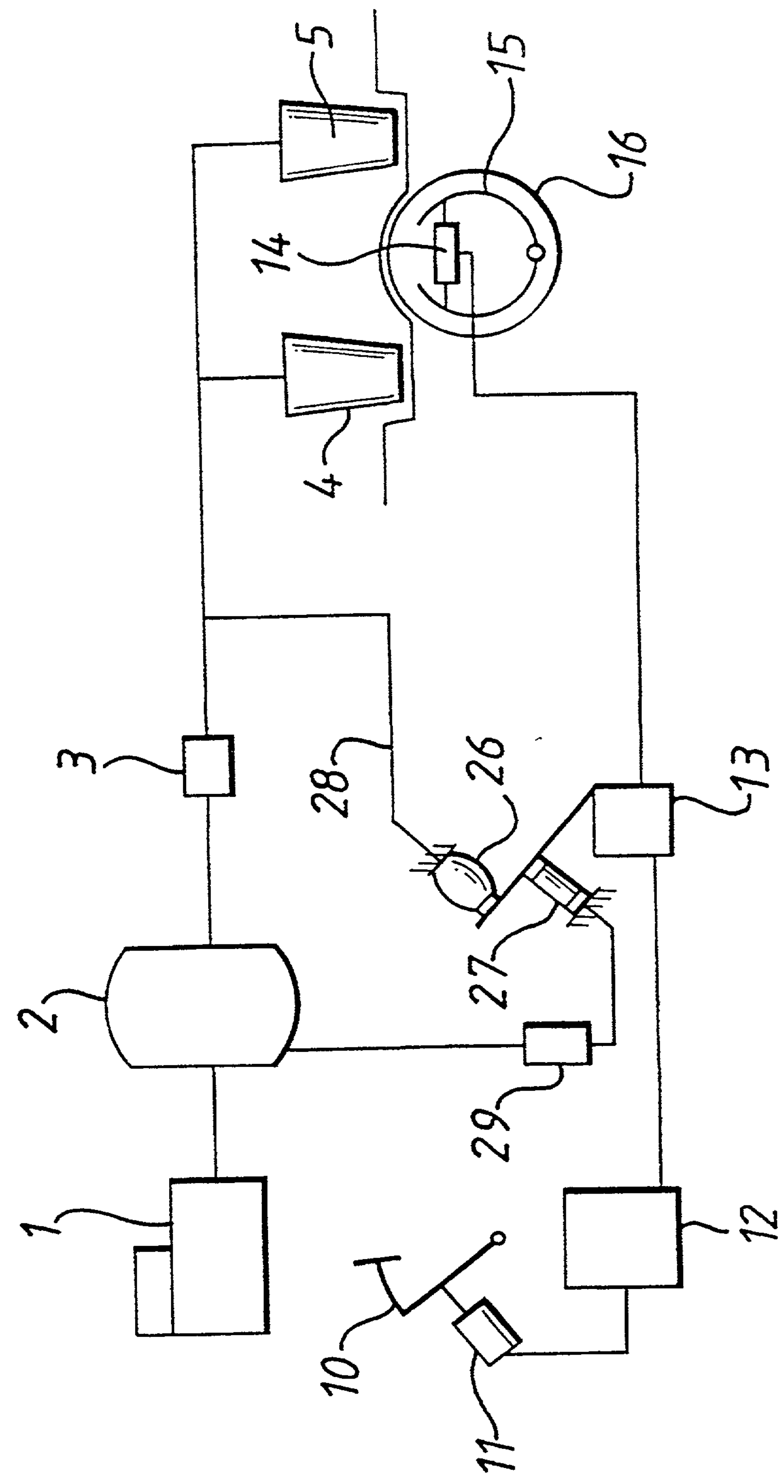


FIG. 1

09/889234

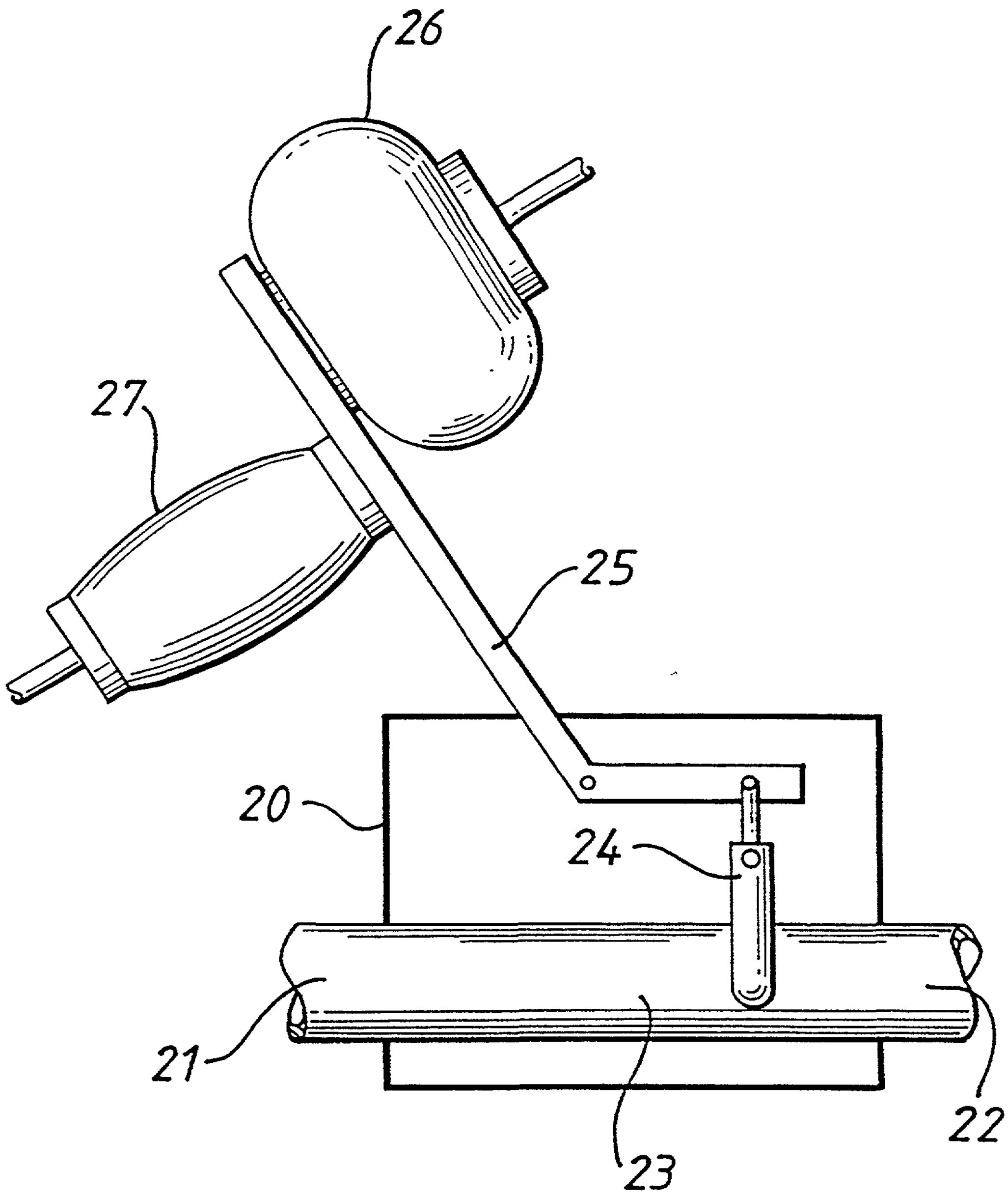


FIG. 2A

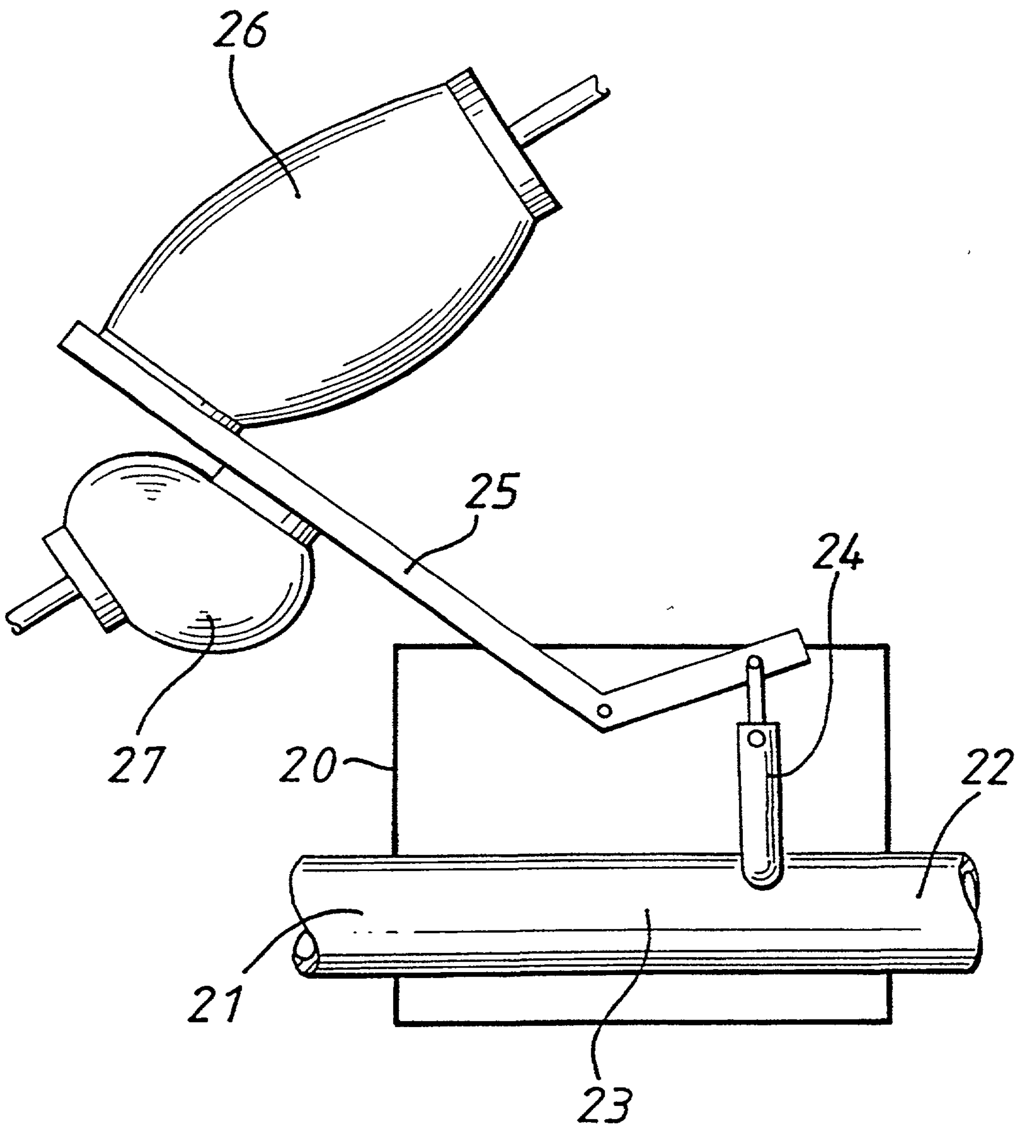


FIG. 2B

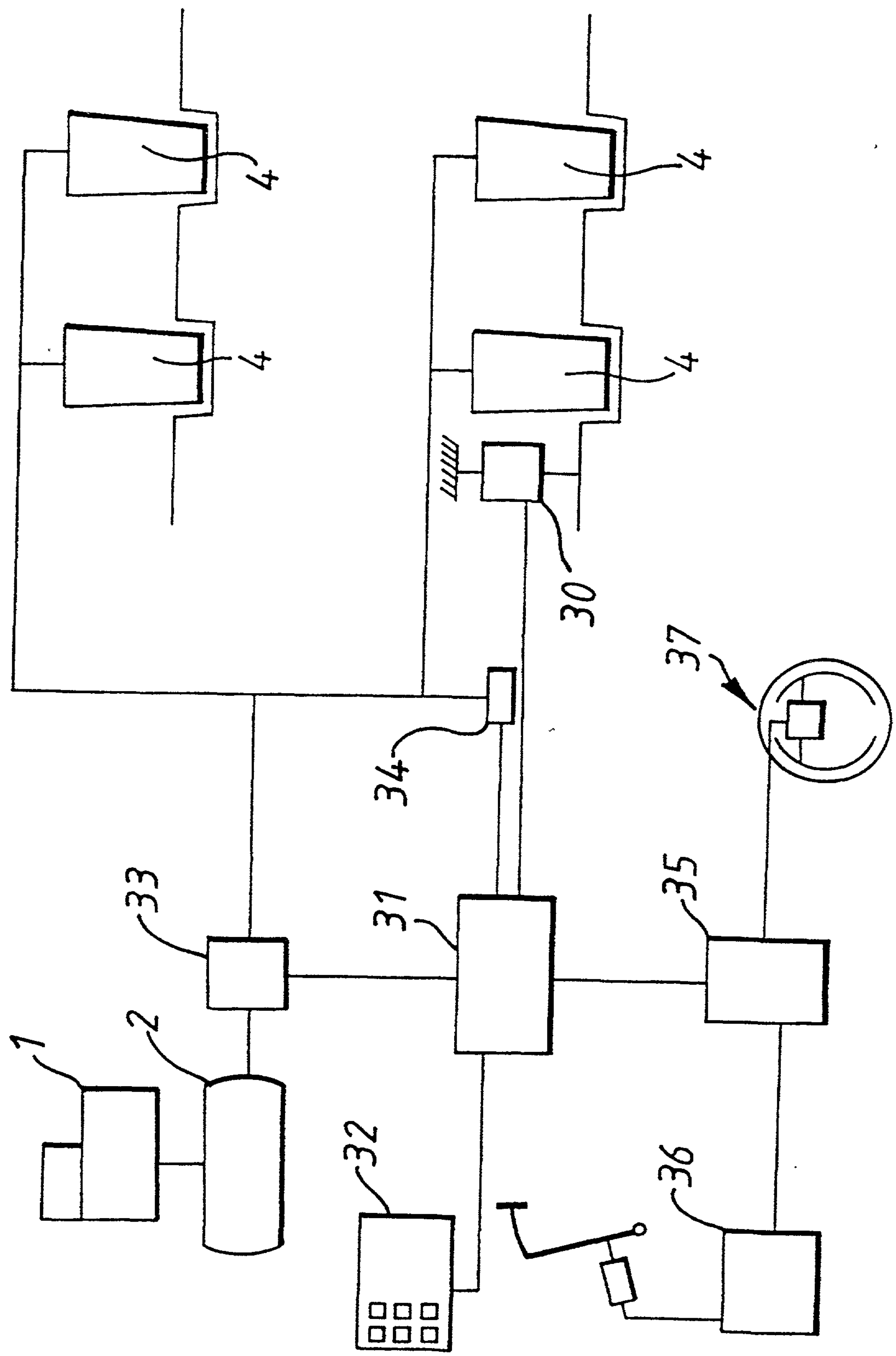


FIG. 3

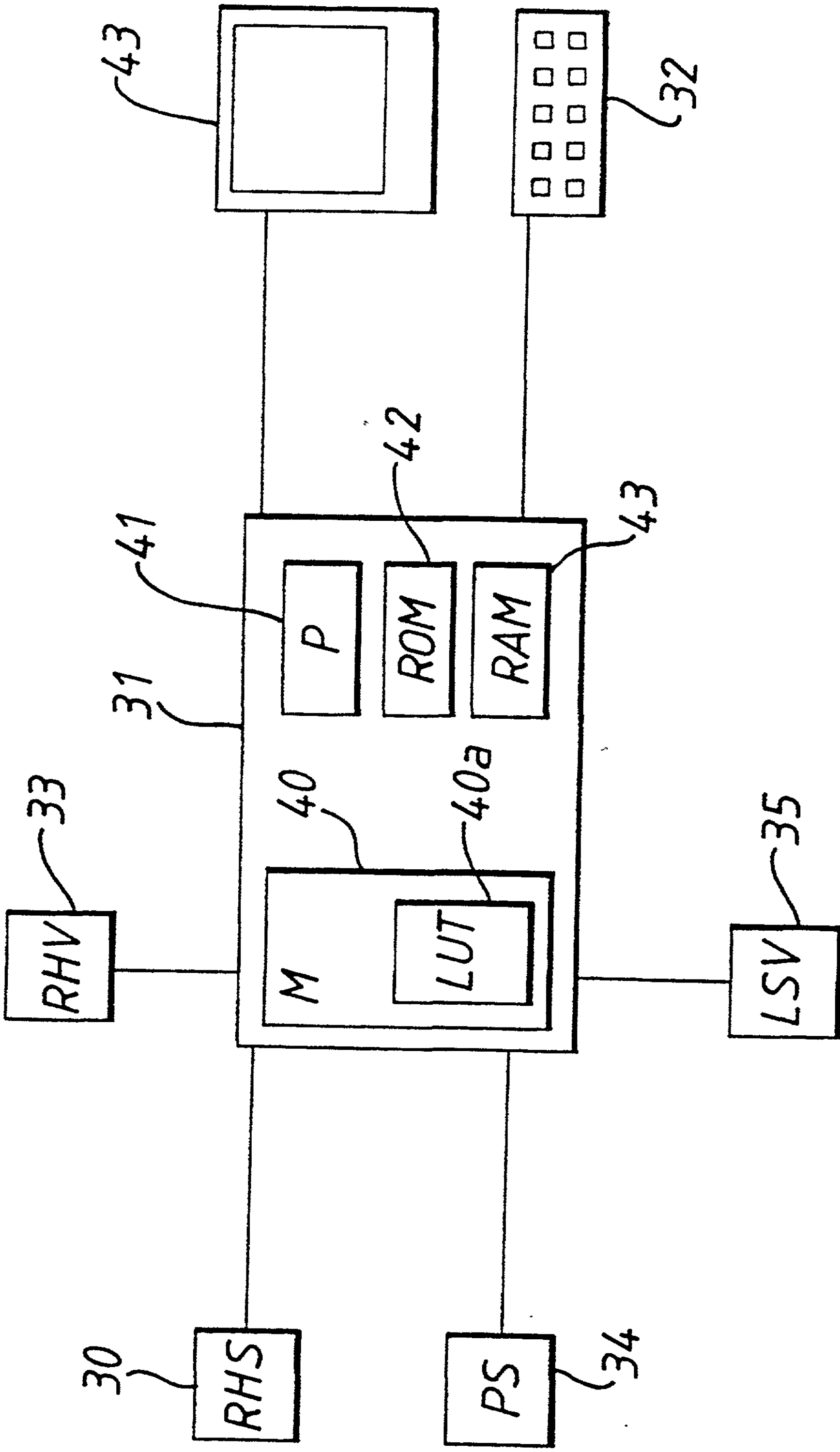
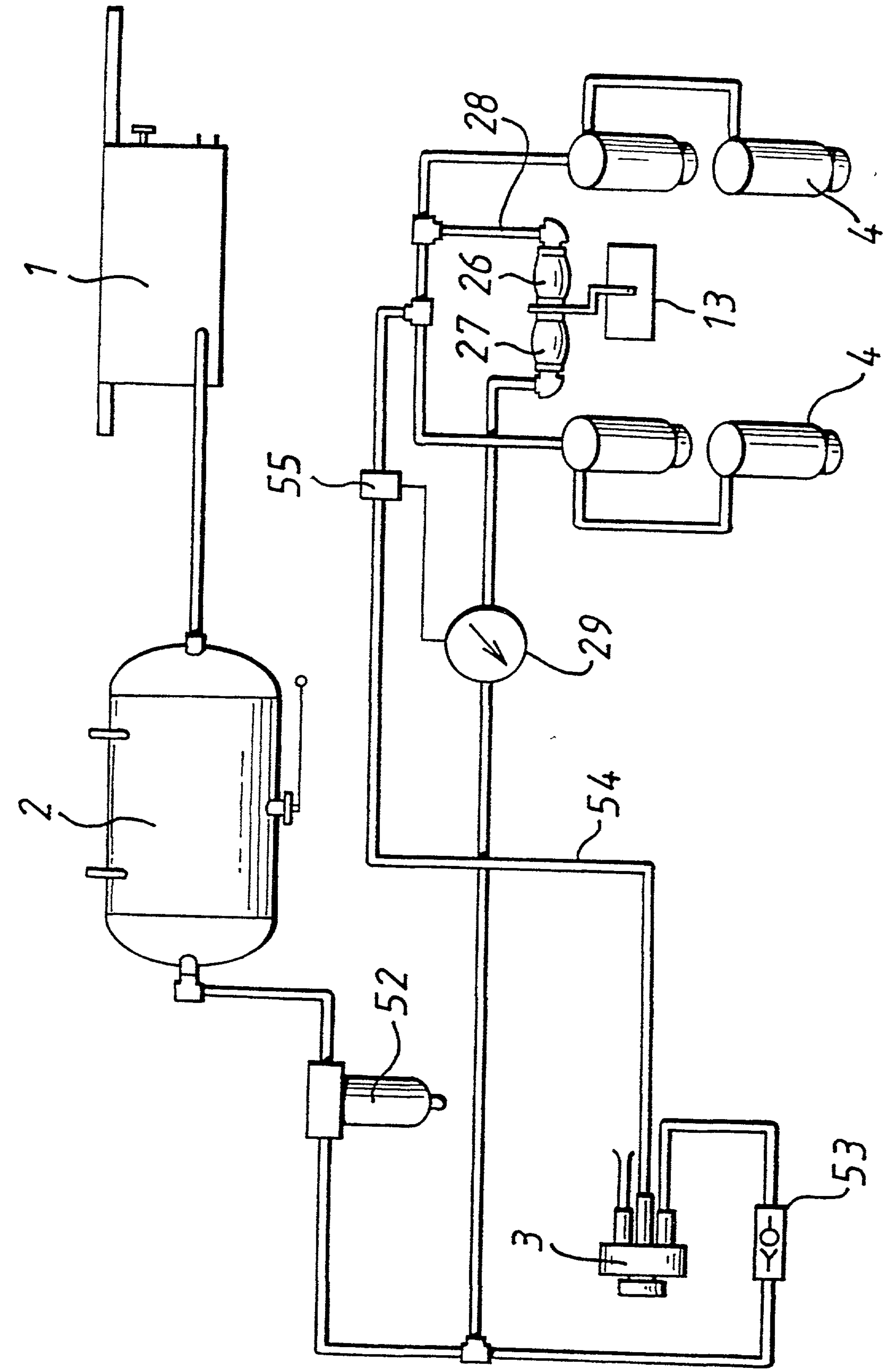


FIG. 4

FIG. 5



DECLARATION AND POWER OF ATTORNEY

As a below named inventor, I hereby declare that: My residence, post office address and citizenship are as stated below next to my name; I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

LOAD SENSING SYSTEM

the specification of which:

is attached hereto; or

was filed as United States Application Serial No. ______________
on July 13, 2001 and was amended on July 13, 2001
(if applicable); or

was filed as PCT International Application Number PCT/GB00/00089
on January 14, 2000 and was amended on ______________
(if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above. I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR § 1.56.

I hereby claim foreign priority benefits under 35 U.S.C. § 119(a)-(d) or § 365(b) of any foreign application(s) for patent or inventor's certificate or § 365(a) of any PCT international application(s), designating at least one country other than the United States, listed below and have also identified below any foreign application(s) for patent or inventor's certificate, or any PCT international application(s) having a filing date before that of the application(s) of which priority is claimed:

Country	Application Number	Date of Filing	Priority Claimed Under 35 U.S.C. 119
Great Britain	9900968.0	January 15, 1999	X YES ☐ NO
			☐ YES ☐ NO

I hereby claim the benefit under 35 U.S.C. § 119(e) of any United States provisional application(s) listed below:

Application Number	Date of Filing

I hereby claim the benefit under 35 U.S.C. § 120 of any United States application(s) or § 365(c) of any PCT international application(s) designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT international application(s) in the manner provided by the first paragraph of 35 U.S.C. § 112, I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR § 1.56 which became available between the filing date of the prior application(s) and the national or PCT international filing date of this application:

Application Number	Date of Filing	Status (Patented, Pending, Abandoned)

I hereby appoint the following attorney and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. **FINNEGAN, HENDERSON, FARABOW, GARRETT & DUNNER, L.L.P., Reg. No. 22,540**, Douglas B. Henderson, Reg. No. 20,291; Ford F. Farabow, Jr., Reg. No. 20,630; Arthur S. Garrett, Reg. No. 20,338; Donald R. Dunner, Reg. No. 19,073; Brian G. Brunsvold, Reg. No. 22,593; Tipton D. Jennings IV, Reg. No. 20,645; Jerry D. Voight, Reg. No. 23,020; Laurence R. Hefter, Reg. No. 20,827; Kenneth E. Payne, Reg. No. 23,098; Herbert H. Mintz, Reg. No. 26,691; C. Larry O'Rourke, Reg. No. 26,014; Albert J. Santorelli, Reg. No. 22,610; Michael C. Elmer, Reg. No. 25,857; Richard H. Smith, Reg. No. 20,609; Stephen L. Peterson, Reg. No. 26,325; John M. Romary, Reg. No. 26,331; Bruce C. Zotter, Reg. No. 27,680; Dennis P. O'Reilley, Reg. No. 27,932; Allen M. Sokal, Reg. No. 26,695; Robert D. Bajefsky, Reg. No. 25,387; Richard L. Stroup, Reg. No. 28,478; David W. Hill, Reg. No. 28,220; Thomas L. Irving, Reg. No. 28,619; Charles E. Lipsey, Reg. No. 28,165; Thomas W. Winland, Reg. No. 27,605; Basil J. Lewris, Reg. No. 28,818; Martin I. Fuchs, Reg. No. 28,508; E. Robert Yoches, Reg. No. 30,120; Barry W. Graham, Reg. No. 29,924; Susan Haberman Griffen, Reg. No. 30,907; Richard B. Racine, Reg. No. 30,415; Thomas H. Jenkins, Reg. No. 30,857; Robert E. Converse, Jr., Reg. No. 27,432; Clair X. Mullen, Jr., Reg. No. 20,348; Christopher P. Foley, Reg. No. 31,354; John C. Paul, Reg. No. 30,413; David M. Kelly, Reg. No. 30,953; Kenneth J. Meyers, Reg. No. 25,146; Carol P. Einaudi, Reg. No. 32,220; Walter Y. Boyd, Jr., Reg. No. 31,738; Steven M. Anzalone, Reg. No. 32,095; Jean B. Fordis, Reg. No. 32,984; Barbara C. McCurdy, Reg. No. 32,120; James K. Hammond, Reg. No. 31,964; Richard V. Burgujian, Reg. No. 31,744; J. Michael Jakes, Reg. No. 32,824; Dirk D. Thomas, Reg. No. 32,600; Thomas W. Banks, Reg. No. 32,719; Christopher P. Isaac, Reg. No. 32,616; Bryan C. Diner, Reg. No. 32,409; M. Paul Barker, Reg. No. 32,013; Andrew Chanho Sonu, Reg. No. 33,457; David S. Forman, Reg. No. 33,694; Vincent P. Kovalick, Reg. No. 32,867; James W. Edmondson, Reg. No. 33,871; Michael R. McGurk, Reg. No. 32,045; Joann M. Neth, Reg. No. 36,363; Gerson S. Panitch, Reg. No. 33,751; Cheri M. Taylor, Reg. No. 33,216; Charles E. Van Horn, Reg. No. 40,266; and Linda A. Wadler, Reg. No. 33,218; Jeffrey A. Berkowitz, Reg. No. 36,743; Michael R. Kelly, Reg. No. 33,921; James B. Monroe, Reg. No. 33,971; Doris Johnson Hines, Reg. No. 34,629; Allen R. Jensen, Reg. No. 28,224; Lori Ann Johnson, Reg. No. 34,498; and David A. Manspeizer, Reg. No. 37,540 and ________________________. Please address all correspondence to **FINNEGAN, HENDERSON, FARABOW, GARRETT & DUNNER, L.L.P.**, 1300 I Street, N.W., Washington, D.C. 20005, Telephone No. (202) 408-4000.

64

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

1-00

Full Name of first Inventor Mark GLAZIER	Inventor's Signature MGlazier	Date 7th August 2001.
Residence Hampshire, Great Britain GBN		Country of Citizenship Great Britain
Post Office Address Magnolia Cottage, Coom be Road, Hillbrow, Liss, Ham pshire GU 33 7 NU, Great Britain		